INSTRUCTION MANUAL

KS-15512 LIST 5AB

OSCILLOSCOPE

ITI ELECTRONICS, INC.
CLIFTON, NEW JERSEY

Amendment 1.
December, 1963

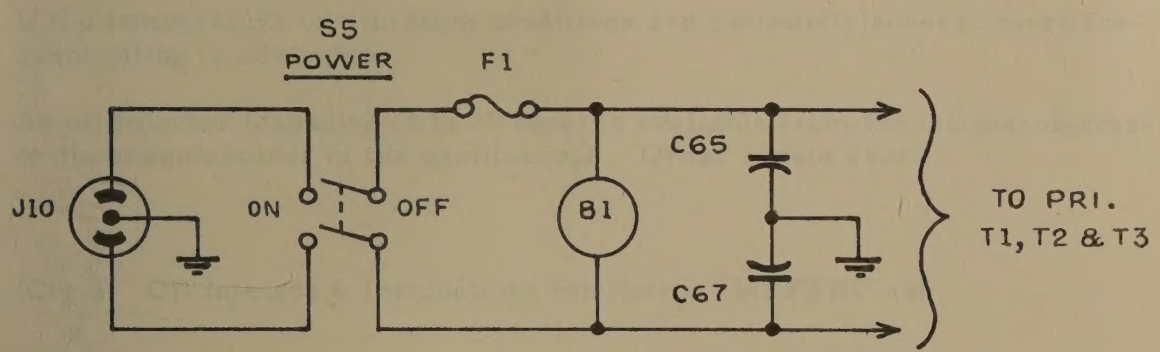
INSTRUCTION MANUAL

KS-15512 LIST 5AB

OSCILLOSCOPE

This amendment covers the difference between the KS-15512 List 5AB Oscilloscope and the KS-15512 List 5A.

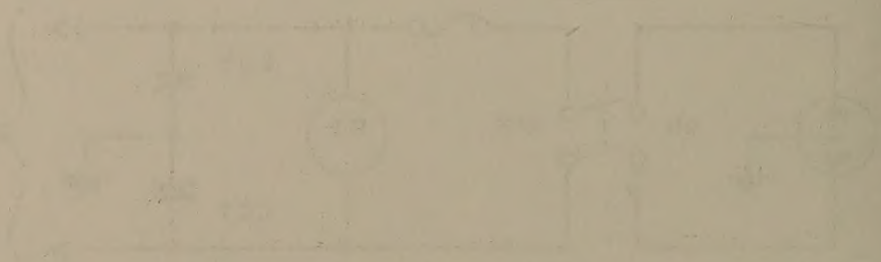
The List 5AB is identical to the List 5A except for the inclusion of a blower system for the reduction of the internal operating temperature. The blower is mounted on the left side of the chassis directly over the rear portion of the vertical sub-chassis. It exhausts heated air upward through the top of the case from the vicinity of the 418A tubes (V5 & V6), as well as providing circulation throughout the equipment. It is connected for continuous operation and actuated by the front panel POWER switch.



A.C. input section from Fig. 12, SCHEMATIC DIAGRAM showing addition of Blower, B1.

Replacement blower, if required, may be ordered from the manufacturer of the oscilloscope as follows:

Schematic Ref. No.	Description	ITI Part. No.	Mfr.
B1	Fan, "MUFFIN" with venturi	264-426	Rotron Mfg. Co.



KS-15512 LIST 5AB

FAN MAINTENANCE

The fan manufacturer recommends that, to insure optimum performance under extreme environmental conditions, the fan should be oiled periodically.

At 110^0 F, or less, the fan should give reliable performance in excess of three years with no oiling.

At higher temperatures and/or unusual vibration conditions, oiling is recommended once a year.

If the temperature or vibration conditions are extremely severe, more frequent oiling is advisable.

An oil injector (capacity 15 to 20 fans) is available from the fan manufacturer or the manufacturer of the oscilloscope. Order should read:

(Qty.) Oil injector & instructions for Rotron "MUFFIN" fan.

TABLE OF CONTENTS

Paragraph		Page
1.	General	1
2.	Description	1
3.	Operation	2
4.	Functions of Circuits	11
5.	Maintenance	13
6.	Technical Specifications	17

LIST OF TABLES

1.	Side Jack Connections for Various Signal Inputs	3
II	Front Jack Connections for Various Signal Inputs	4
III	Maintenance Parts List	19
IV	List of Manufacturers	29

LIST OF ILLUSTRATIONS

1.	KS-15512, List 5A Oscilloscope	ii
2.	Oscilloscope, KS-15512, List 5A Top Internal View	iii
3.	Oscilloscope, KS-15512, List 5A Bottom Internal View	iv
4.	Video Response	5
5.	Use and Interpretation of Standard Scale.	9
6.	Voltage & Waveform Chart	16
7.	Calibrating Circuit for KS-15512 Oscilloscope	18
8.	All White Picture Signal	18
9.	Horizontal Sync. Pulse Interval	18
10.	Square Wave Response	18
11.	Scale Signal Measuring Level	18
12.	KS-15512, List 5A, Oscilloscope Schematic Diagram	31

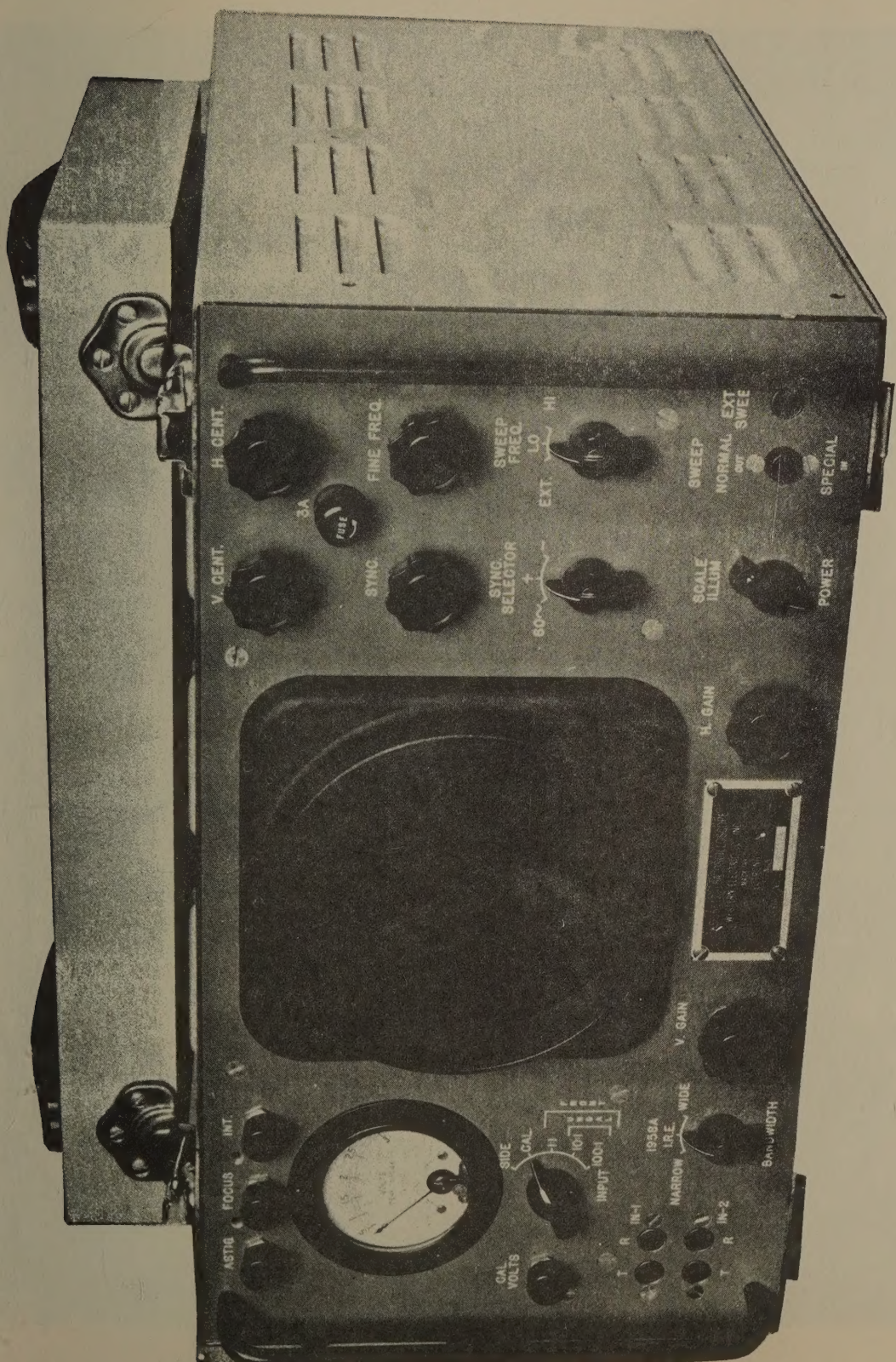


FIGURE 1. KS-15512 LIST 5A OSCILLOSCOPE

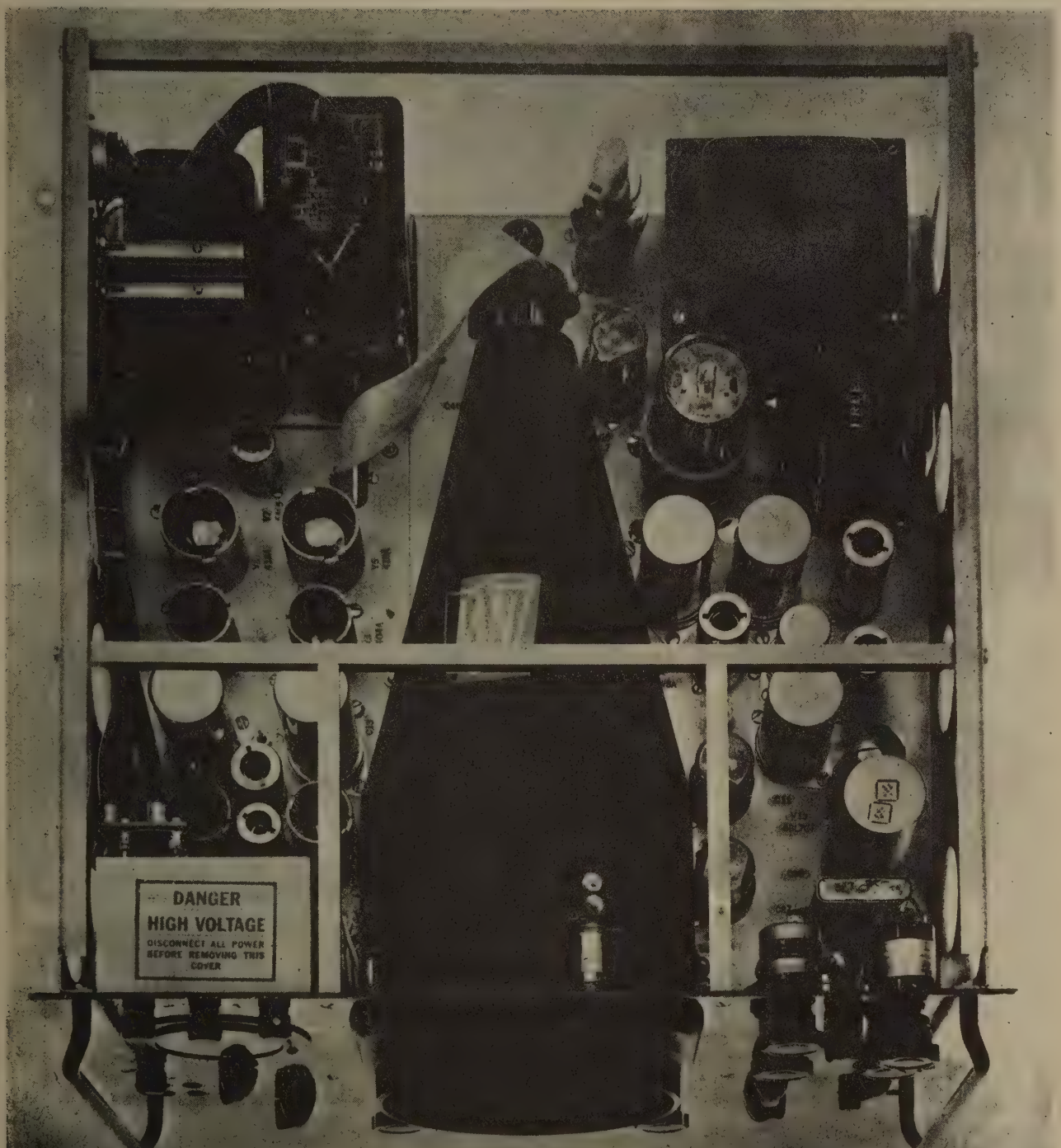


FIGURE 2. OSCILLOSCOPE, KS-15512, LIST 5A
TOP INTERNAL VIEW

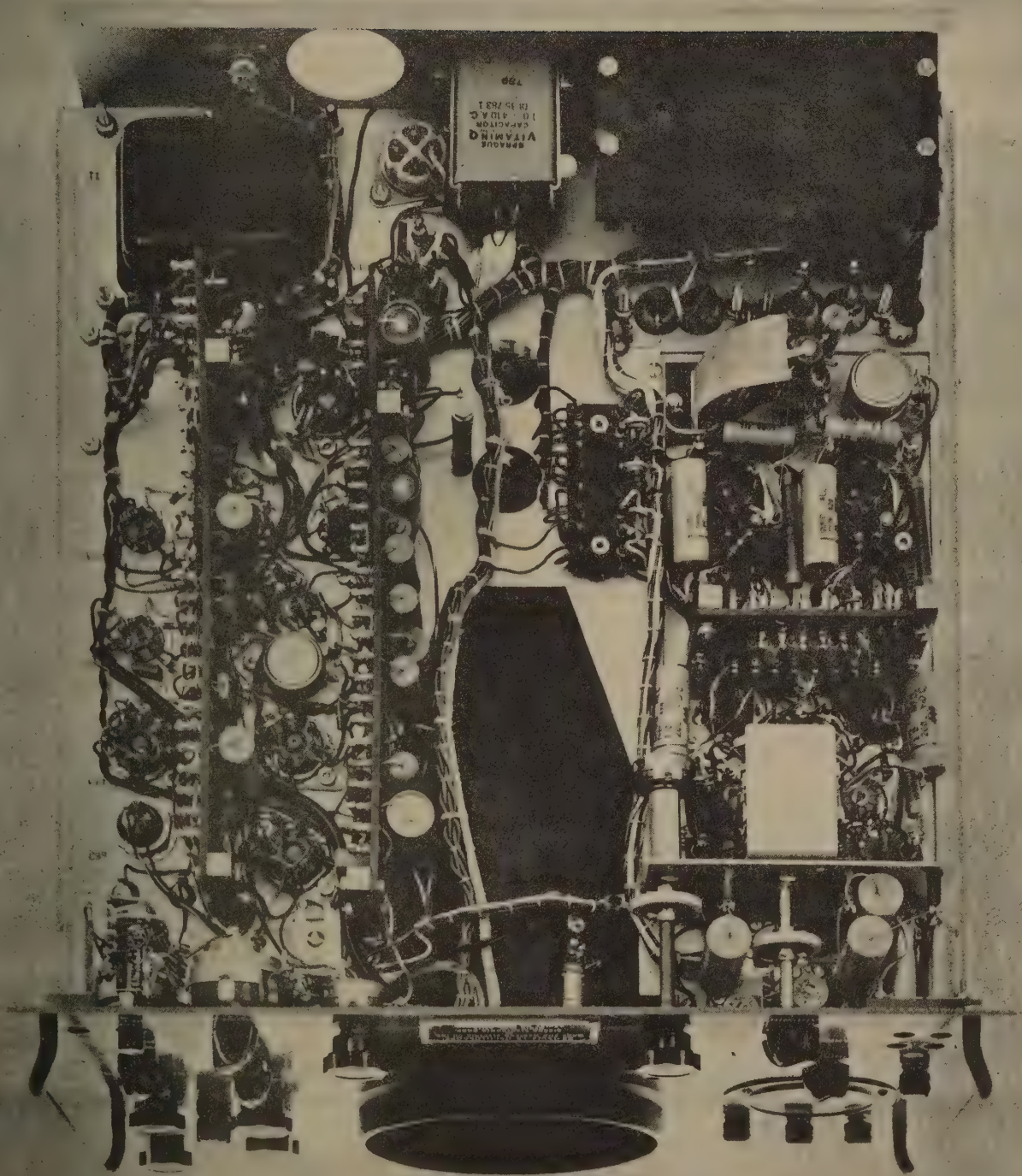


FIGURE 3. OSCILLOSCOPE, KS-15512, LIST 5A
BOTTOM INTERNAL VIEW

OPERATING INSTRUCTIONS

1. GENERAL

1.01 The KS-15512 Oscilloscope is a compact, portable, instrument designed for waveform analysis and amplitude measurements of video signals encountered in color and monochrome television circuits, and employs a 5-inch cathode-ray tube. The oscilloscope is supplied with an edge-illuminated scale and camera mounting bezel to facilitate the measurement of signals and the photographic recording of waveforms. It contains an extremely flat, linear, wide-band, vertical amplifier and, therefore, can be used for accurate voltage measurements up to and beyond 5 Mc. It may also be used as a general purpose instrument in many applications because of its high sensitivity, excellent synchronizing capability, precision calibrating circuits, wide input voltage range, and high degree of horizontal expansion. For standardization of frequency response interpretation of television signals, the bandwidth of the vertical amplifier can be set by a front panel control.

1.02 The KS-15654 or KS-5799 Video Monitor may be used in conjunction with this instrument, for the combined purpose of picture and waveform analysis of video signals.

1.03 The KS-15512-L5A Oscilloscope is supplied with a low capacitance, high-impedance probe, having an attenuation factor of 10 to 1 (20 db loss); a 10 ft. power cable; a pair of side brackets; and hardware for mounting in a standard relay rack.

2. DESCRIPTION (See Figures 1, 2 and 3)

2.01 The KS-15512 Oscilloscope is housed in a rugged aluminum carrying case with a removable hinged cover. Two heavy-duty suitcase latches fasten the cover to the case. The unit may be carried by means of two leather covered, flexible steel handles mounted on the cover. The case and cover are finished in a smooth, light gray paint. The unit is ventilated by means of louvers in the side and top of the case.

2.02 The case is held to the chassis by two captive camlock fasteners which, when opened, permit the chassis to be pulled free from the case on supporting slides. Protective covers are placed over components on both sides of the chassis to prevent accidental contact with high voltage points. The cathode-ray tube, enclosed by a mu-metal shield, is removable from the front of the unit. A plexiglass window provides protection against accidental breakage of the cathode-ray tube.

2.03 The front panel consists of the following controls, symmetrically arranged about the 5-inch cathode-ray display tube.

1. ASTIG
2. INT (INTENSITY)
3. FOCUS
4. CAL. VOLTS (Calibration control)
5. INPUT switch (SIDE, CAL.)
   FRONT
   (1:1 10:1, 100:1)
6. IN-1-T, IN-1-R (input jacks)
7. IN-2-T, IN-2-R (input jacks)
8. BANDWIDTH switch (NARROW, 1958A I.R.E, WIDE)
9. V. GAIN
10. H. GAIN
11. H. CENT
12. V. CENT
13. SYNC
14. FINE FREQ.
15. SWEEP FREQ range switch (EXT., LO, and HI)
16. SYNC SELECTOR switch (60 cps, +, and -)
17. EXT. SWEEP input
18. POWER switch and SCALE ILLUM
19. SWEEP switch (NORMAL-OUT, SPECIAL-IN)

Also located on the front panel are the Voltmeter for adjusting the calibrating voltage, and the fuse.

On the left side of the case are the power receptacle and side input jacks, marked IN-3-T, IN-3-R, IN-4-T and IN-4-R. An alternate position of the power receptacle is provided at the rear of the unit.

+185 VOLT ADJ., LOW FREQ. ADJ. HOR TRACK ADJ., and HIGH VOLTAGE ADJ. controls are provided on the chassis. There are also four attenuator adjustment capacitors, three compensation coils, and two 3.579 MC traps.

2.04 The vertical amplifer components are mounted on a sub-chassis which can be removed for replacement or separate testing purposes.

The heater supply for the vertical amplifier is obtained from a voltage regulated transformer, to insure long tube life and stability.

3. OPERATION (See Figure 12)

3.01 Connect the power cable to the power receptacle located on the left side of the unit, and connect the other end to a 115 volt, 50/60 cps power outlet suitable for a three-bladed polarized power plug with a ground post.

3.02 Turn POWER switch CW until it snaps on. Set the V. GAIN control to the maximum counterclockwise position with power on, in order to eliminate pickup while adjusting the oscilloscope, and turn the SWEEP FREQUENCY range switch to HI position. Turn the INPUT switch to 1:1 position. Press SWEEP switch to NORMAL-OUT position.

3.03 Adjust the V. CENT control so as to position the trace along the vertical axis at a convenient point; adjust the H. GAIN control so that the length of the trace is completely displayed on the face of the cathode-ray tube.

3.04 Adjust the H. CENT control so as to position the trace along the horizontal axis at a convenient point. Readjust the H. GAIN control so that the length of the trace is approximately equal to the diameter of the tube.

3.05 Adjust the FOCUS and ASTIG. controls for the sharpest and most distinct trace. Then adjust the INT control for desired brightness of trace. It may be necessary to refocus after adjusting the intensity.

TABLE 1

For Side Jacks with INPUT Switch in SIDE position

SIDE JACK CONNECTIONS FOR VARIOUS SIGNAL INPUTS

JACK DESIGNATION	75 OHMS INPUT UNBALANCED VIDEO		124 OHMS BALANCED VIDEO
	CONDITION-1 Black Negative Video	CONDITION-2 Black Positive Video	CONDITION-3 Balanced Video
IN-3-T	Signal Input	Short	Black Neg.
IN-3-R	Short	Signal Input	Black Pos.
IN-4-T	75 Ohms Term.	Open	124 Ohms
IN-4-R	Open	75 Ohms Term.	Balanced Termination

TABLE II

For Front Jacks with INPUT Switch in FRONT Position

FRONT JACK CONNECTIONS FOR VARIOUS SIGNAL INPUTS

JACK DESIGNATION	75 OHMS INPUT UNBALANCED VIDEO		124 OHMS BALANCED VIDEO
	CONDITION-4* Black Negative Video	CONDITION-5* Black Positive Video	CONDITION-6* Balanced Video
IN-1-T	Signal Input	Short	Black Neg.
IN-1-R	Short	Signal Input	Black Pos.
IN-2-T	75 Ohms Term.	Open	124 Ohms Balanced Termination
IN-2-R	Open	75 Ohms Term.	

*NOTE: Condition 4 may be used with INPUT switch in 1:1, 10:1, or 100:1 position. Condition 5 or 6 must be used only with the INPUT in the 1:1 position.

3.06 Vertical Amplifier: Input Connections and Operation

Apply signal to desired input jacks. The signal may be balanced or unbalanced: TABLE 1 and TABLE II indicate the proper terminations and terminating points to be used.

For unbalanced inputs, the signal should be applied through a P2BJ type unbalanced coaxial cord or its equivalent. A 368A Plug should be used for the 75-ohm termination, and a 358A Plug (with bare strap between center conductor and shell) should be used as a shorting plug for the proper termination of the multiple input jack arrangement.

For balanced, inputs, the signal should be applied through a P3AH type balanced coaxial cord, or its equivalent. A 341F Plug should be used for the 124-ohm termination in the multiple input arrangement.

Adjust the V. GAIN so that the vertical size of the signal displayed is from 1 to 3 inches.

3.07 Set the Bandwidth switch to the proper position. The WIDE band is used for multiburst testing of waveform analysis requiring the widest bandwidth. The 1958A I.R.E. bandwidth follows the curve data of the IRE specifications and is used when making signal level measurements. The NARROW bandwidth is employed when the oscilloscope is operated in conjunction with the W.E. J64047A Transmission Measuring Set, and for measurements requiring high sensitivity (see Figure 4 for specific frequency response curves).

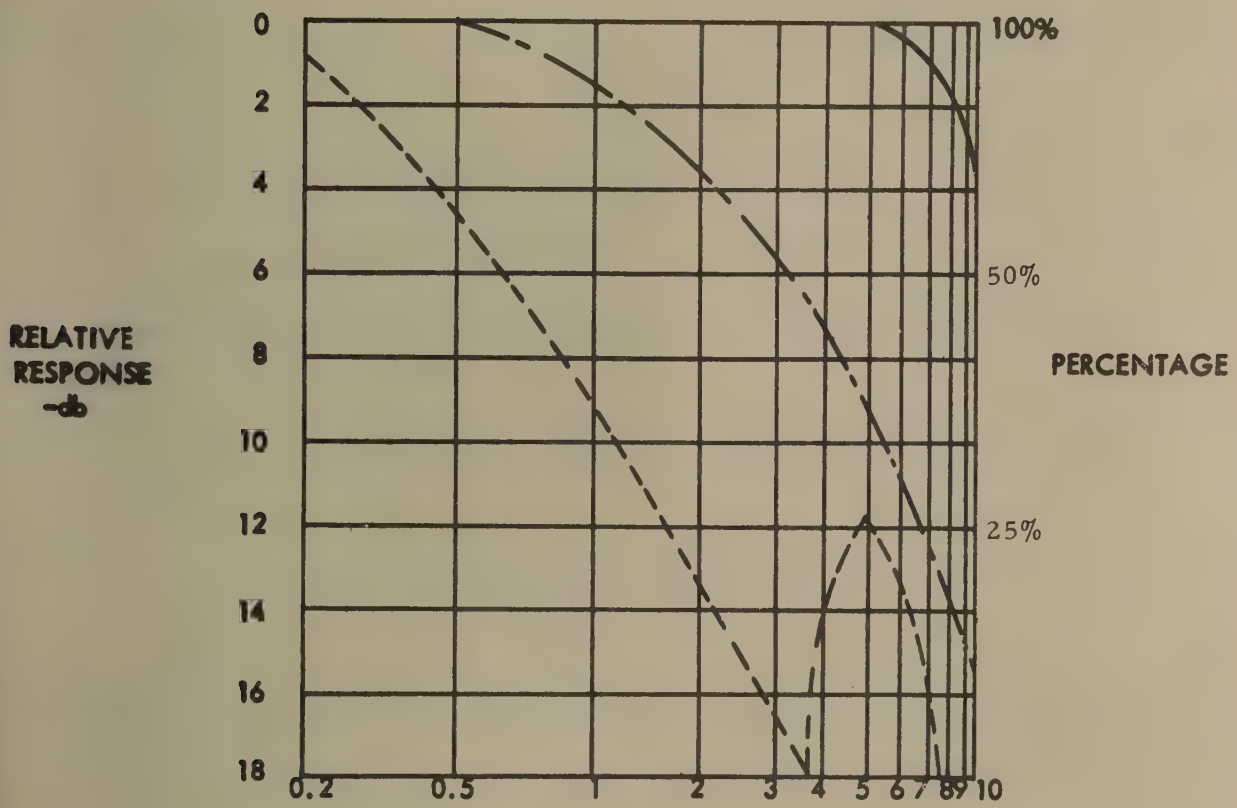


Figure 4. Video Response

3.08 Normal Horizontal Sweep: Synchronization and Adjustment

A. Sync. Mode Adjust:

For a TV signal, Figure 5 illustrates the correct sync. mode which shows the H. Sync. pulse occurring at the right hand end of the sweep. When using the Model 61C Generator, Figure 8 indicates the correct presentation. The SYNC. and FINE FREQ controls are alternately adjusted, as described in this paragraph and in paragraph 3.09, until this condition is attained.

If the controls are improperly adjusted, synchronization may occur on blanking, which is indicated by the disappearance of the right hand sync. pulse.

For low frequency sweep synchronization, the sync mode is the same; i.e., the V sync pulses should occur at the right hand end of the sweep.

The result of incorrect synchronization is illustrated in Figure 9A. The leading and trailing edges of the horizontal sync pulse (which are designated by the 1-inch expansion markers) exhibit a considerable degree of jitter. By alternately adjusting the SYNC and FINE FREQ controls, the jitter may be eliminated, as shown in Figure 9B.

If the jitter cannot be eliminated, examine the incoming signal for the following defects:

1- Low Frequency tilt.
2- Tilt in the horizontal sync pulses.
3- Hum modulation.

In addition, jitter may be caused when observing a T.V. signal not locked to the local 60-cycle power source. Under these conditions, the jitter will appear to fade in and out, due to the frequency differences in the power sources.

B. Low Frequency Sync. Adjust:

To examine the Vertical interval of a television signal, synchronize as described above, displaying two Vertical fields. Rotate the H. GAIN control clockwise for the desired expansion, and re-center.

When the low frequency sweep is desired (18 to 80 cps), turn the SWEEP FREQ control to LO, set SYNC control fully CCW, and adjust the FINE FREQ control until the waveform pattern displayed consists of one or more cycles

of the signal and appears to be moving slowly from right to left. For a television signal, observe the polarity of the synchronizing pulses on the screen. If they are positive, set SYNC. SELECTOR switch to +, or if they are negative, set SYNC. SELECTOR switch to -. For 60 cycles synchronization, set SYNC SELECTOR to 60 cycles. For other input signals, the type of sync is selected as desired. Rotate the SYNC control clockwise until the waveform pattern suddenly becomes stationary and, therefore, is locked synchronously with the sweep. For best synchronization, a minimum of sync should be used.

C. High Frequency Sync. Adjust:

To examine the alternate Vertical interval, reduce the horizontal size to 3 inches. Turn the SYNC control slowly counterclockwise until the trace starts to slip slowly from right to left. When the vertical interval (which had previously been locked in at the right side of the display) approaches the center, quickly rotate the SYNC control clockwise so that the display is again synchronized. The alternate interval is now at the center of the picture, and its complete Vertical period may be examined. (See Section 5.04 for high frequency sweep tracking procedure.)

3.09 When the high frequency sweep is desired (4,000 to 16,000 cps), turn the SWEEP FREQ control to the HI position, and set SYNC control fully counterclockwise. Rotate SYNC control clockwise until pattern becomes stationary. Adjust the FINE FREQ control until the desired number of cycles is displayed. Select the SYNC. SELECTOR switch position as described in 3.08b. Re-adjust both SYNC and FINE FREQ controls for best synchronism. (See Figures 5 and 9.) Adjust the H. GAIN control so that the detail in the waveform is sufficiently expanded.

3.10 Special Horizontal Sweep:

The purpose of the Special Sweep is to offer an expanded view of the video information contained in the first number of horizontal lines following the Vertical Blanking period. To observe these lines, synchronize the normal low-frequency sweep as outlined in 3.08b. Press the SWEEP switch into the SPECIAL-IN position. The Special Sweep will automatically synchronize. Expand the sweep to the desired horizontal width, and position the video information to be observed to the center of the CRT. Alternately adjust the FOCUS and ASTIG. controls for the sharpest focus.

To examine the video information following the alternate interlaced Vertical interval, re-position the display so that the last equalizing pulse and first horizontal pulse in the Vertical Blanking interval may be observed. The period between them will be that of two equalizing pulses or two horizontal synchronizing pulses. Rotate the SYNC control fully counterclockwise, and then clockwise, until the trace is again locked in. Note the period between the equalizing and horizontal pulses. It should be the alternate of the period previously observed. If it is not,

repeat the above SYNC control operation until the proper time interval appears. The video information may now be examined.

3.11 An external sweep may be connected to this instrument at the EXT. SWEEP jack. When an external sweep is used, the SWEEP range switch must be turned to EXT. This sweep may be expanded by means of the H. GAIN control.

3.12 Amplitude Measurements of Signals:

A. General Method:

1.- Apply the signal voltage as described in section 3.06 to the oscilloscope, and adjust the controls so that an adequate display of the signal is observed on the cathode-ray tube.

2.- Rotate the SCALE ILLUM. control clockwise until the scale is lighted to the desired intensity.

3.- Using the scale, note the vertical distance between the extreme amplitude peaks of the signal. DO NOT DISTURB the V. GAIN control after making the measurement.

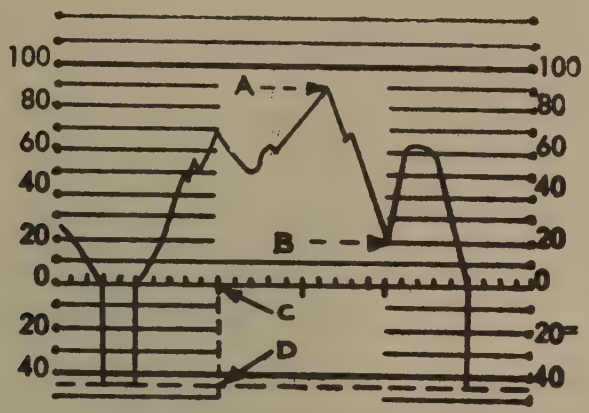
4.- Turn the INPUT switch to the CAL. position (See Fig. 7.)

5.- Adjust the CAL. VOLTS control so that the calibration signal (60 cps) displayed is equal in amplitude to the signal as determined by the transparent ruled scale. (Synchronization of the calibrating signal is not necessary) The reading on the voltmeter scale, multiplied by the input attenuator position (selected in step 1 of this measurement) determines the signal amplitude in peak-to-peak voltage.

B. Scale Interpretation:

Standardizing the response characteristic of the oscilloscope serves to minimize possible differences in interpretation of signal levels. To further insure uniformity in interpreting the oscilloscope indication, the measurement of synchronizing and blanking levels should be observed at a point in the waveform where the voltages representing these levels are substantially at their steady state value. The longer duration signals, of both synchronizing and blanking levels, which occur durin g the vertical synchronizing interval, are suitable. A representation of the appearance of these portions is shown in Figure 5, the measurements being made as indicated to minimize errors due to transmission distortion.

In the measurement of noncomposite signals, blanking level may similarly be measured during the vertical blanking interval. In measuring picture signal portions, important information-bearing signal peaks will be normally held within the 0 to 100 scale range. Certain spurious highlight signals may occasionally be allowed to exceed this range. Where comparison measurements are being made at different points in a transmission system, it is important to insure that identical peaks are being considered.



A. Measure White Peak Here
B. Measure Black Peak Here
C. Measure Blanking Level Here
D. Measure Sync Level Here

Figure 5. Use and Interpretation of Standard Scale

Measurements made within the 1958A I.R.E. standard scale in the above manner will be expressed as in the following illustrative example:

White Peak: 90 (90% of Blanking to Reference White Level)

Black Peak: 13 (13% of Blanking to Reference White Level)

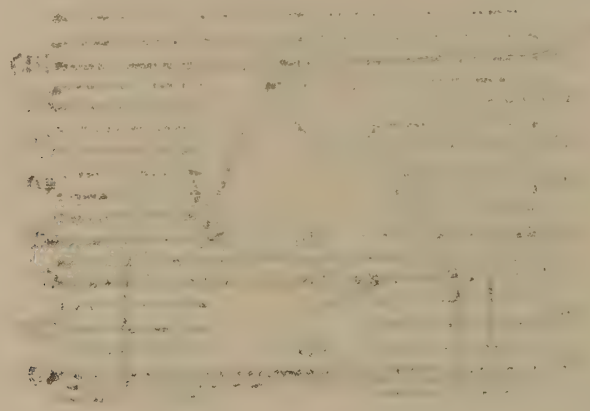
Synchronizing Level: 43 (43% of Blanking to Reference White Level)

Refer to Figure 5 for presentation as it would appear on oscilloscope screen.

C. Oscilloscope Calibration

In applications requiring the measurement of signals less than 0.5 volts peak-to-peak, the following procedure may be followed:

1.- Turn the INPUT switch to CAL. position



2.- Adjust the CAL. VOLTS control so that the voltage read on the A-C voltmeter is equal to 0.5 volts.

3.- Next adjust the V. GAIN control so that the peak-to-peak amplitude of the displayed calibrating signal is equal to 10 scale divisions (0-100). Therefore, each scale division is equal to 0.05 volts. The oscilloscope is now calibrated. DO NOT DISTURB the V. GAIN control.

4.- Turn the INPUT switch to the signal input position and synchronize the frequency of the unknown signal.

5.- Note the peak-to-peak amplitude of the signal in terms of scale divisions on the ruled screen.

6.- To obtain the peak-to-peak voltage of the signal, multiply the number of scale divisions by 0.05.

3.13. Time Measurements of Signals:

a. Apply the signal voltage to be measured to the oscilloscope as per paragraph 3.06 and adjust the scope controls for an adequate synchronized CRT display as described in paragraphs 3.08 and 3.09.

b. Remove the signal voltage and apply a sine wave from a 61B or C Signal Generator or equivalent oscillator to the scope. (For a low frequency signal, apply a since wave approximating 10 kc. For a high frequency signal, apply a sine wave approximating 1 mc.) Without readjustment of the FINE FREQUENCY control, lock in the sine wave display by means of the SYNC control. Adjust the V. GAIN control for a sine wave deflection of about 1 inch on the scope. Adjust the V. CENT control until the lower tips of the sine wave are displayed on the "O" line of the signal measuring scale.

c. Adjust both the H. GAIN and H. CENT. controls until the sine wave peaks coincide with the small vertical markers on the "O" line of the scale. This then indicates that the vertical markers are calibrated in time according to the horizontal sweep setting. (EX. if the peaks of a 1 mc sine wave fall on every vertical marker, then each space represents a 1 microsecond interval; if each since wave peak is set to fall on every second marker, then a 1 microseoond interval is represented by two divisions or every marker represents a 0.5 microsecond interval, etc. Similarly a 500 kc, 200 kc, 100 kc, 10 kc, etc. sine wave positioned on the scale markers will indicate a 2, 5, 10, 100 microsecond etc. time interval respectively).

d. Without readjustment of the H. GAIN control, or the FINE FREQUENCY control, remove the reference sine wave signal and reinsert the

signal voltage. Reference the portion of the signal to be measured on the "O" horizontal line and count the number of markers within which the signal falls. Multiply this number by the time interval scale determined in paragraph c, above. The result yields the time interval of the signal voltage being measured.

4. FUNCTIONS OF CIRCUITS (See Figure 12)

4.01 Vertical Amplifier

The vertical amplifier consists of tubes V1 through V7, and their associated circuits. If an unbalanced signal (as described in section 3.06) is fed to V1 or V2, the stage acts as a cathode-coupled phase inverter. For a balanced signal fed simultaneously to V1 and V2, the stage acts as a push-pull amplifier. The V. GAIN control, interconnecting the cathodes of V1 and V2, can vary the gain of the vertical amplifier 20 db by changing the amount of cathode degeneration. As the V. GAIN control is decreased from maximum sensitivity, L1 and L2 become increasingly effective as high frequency compensation coils for V1 and V2 respectively. The BANDWIDTH switch in the plates of V1 and V2 selects the proper plate leads in accordance with its setting at WIDE, 1958A I.R.E., or NARROW positions. Capacitors C13B and C15B in the plate circuit of V1 and V2 are used to produce low frequency compensation. Coarse low frequency compensation adjustment is effected by resistors R52 and R53 in the grids of V3 and V4, the input stage of the balanced two-stage feedback amplifier. These resistors are normally shorted out but may be inserted by removing and shorting wires, when additional low-frequency compensation is necessary for proper adjustment of the fine LOW FREQ. ADJ. control, R58. The cathode circuit of V3 and V4 contains the variable high frequency compensation coil L7, which is peaked and set with the V. GAIN in the maximum position, Degenerative feedback is accomplished by forming a loop from the plates of the feedback amplifier output tubes, V5 and V6, to the cathodes of V3 and V4. A high degree of feedback is made possible by the very large figure of merit of the output tubes, V5 and V6, and enables the ampliifier to be extremely stable and linear.

The D.C. setter, V7, clamps the negative going peaks of the signal to the base line so that the varying video signals will have a stable D.C. reference on the scope tube.

4.02 Synchronizing Circuits:

The dual cathode follower, V8, couples two signals, 180^0 out of phase, from the vertical amplifier to positions - and + of the three-position SYNC. SELECTOR switch. The third position is connected to a 60-cycle voltage source, and in this way, positive, negative, or 60-cycle line synchronization may be obtained by the proper positioning of the SYNC. SELECTOR switch. The signal, which is amlified by the Sync Separator Amplifier, V17B, is partially clipped of its video information by the diode, CR6. The synchronizing signal is then completely clipped

from the main signal and is amplified by the Sync. Separator, V19A. The cathode follower section of V19, in addition to clipping the negative sync peaks, enables the SYNC. control, R93, to vary the amplitude of the sync. signal without materially affecting the rise time of the signal. The vertical integrator network, N1, and the differentiating network, R103 and C53, shape the signal simultaneously, The integrated or differentiated sync. pulse may be selected by setting the SWEEP FREQ. switch to LO or HI.

4.03 Horizontal Sweep and Amplifier:

The sweep generator, V9, generatoes a sawtooth wave whose rate depends on the time constants of the parameters selected by the setting of the SWEEP FREQ switch and the FINE FREQ control. The exceptional linearity of the sweep is maintained by the feedback from the Sweep Generator Bootstrap, V13A, which holds the charging current through the sweep RC network, R106 and C56 or C57, constant. The Normal and Special Sweeps are chosen by selecting the output of V13A from the cathode or plate, respectively. An external sweep signal may be used by switching the SWEEP FREQ switch to EXT. and inserting the signal at the EXT. SWEEP jack. The width of the H. sweep can be varied by the H. GAIN adjustment, R101, which controls the amplitude of the sweep to the Phase Inverter, V11A and V12A. The Phase Inverter drives a Push-Pull Amplifier, V11B and V12B, whose output is coupled to the Horizontal plates of the CRT.

The excellent stability characteristics of the sweep and horizontal amplifier circuits is obtained by the use of regulated voltages, and a high level of feedback. The plate D.C. supply for the Sweep Generator and Phase Inverter is obtained from the +185-volt regulated supply. The centering voltages to the Phase Inverter triode grids are held to a very close tolerance by the voltage regulating zener diodes, CR4 and CR5. The four amplifier sections of the horizontal amplifier have both local cathode feedbacks, and interstage feedback, from the plates of the output tubes to the cathodes of the Phase Inverter.

Because direct coupling is used between stages, the positioning of the trace horizontally, by varying the H. CENT. control, is instantaneous.

Blanking is obtained by utilizing the positive retrace pulse at the cathode of the Sweep Generator, V9. For Sweep-Normal operation, this pulse is amplified and inverted by Blanking Amplifier V10B and fed to the grid of the CRT, thereby cutting if off during the flyback time.

During the Sweep-Special operation, the positive pulse is cathode-coupled to the Blanking Amplifier, V10B, which amplifies but does not invert the pulse. The pulse now blanks the forward sweep and unblanks the sweep retrace. Switch S6 reverses the polarity of the sweep so that the special sweep also scans from left to right.

4.04 High Voltage Regulation:

The High Voltage Regulator tube, V10A, is placed in series with the cathode circuit of the High Voltage Rectifier tube, V15, to ground. In this position it acts as a variable resistor. Its grid is connected to the CRT negative high voltage divider and senses any change in the high voltage. If this change is in the negative direction, the bias on the tube increases, effectively increasing its resistance in the circuit. The increased voltage drop across it is reflected to the H.V. output, making it more positive. A positive increase in the high voltage causes the tube to operate conversely. In this manner, the high voltage to the CRT is regulated to within a few percent regardless of changes in A.C. line voltage, or in the current drawn by the CRT.

4.05 Low Voltage Regulation:

The low voltage regulator supply consists of the series pass tube, V13B, and shunt regulator, V17A, and the voltage reference tube, V18. The high degree of D.C. amplification of the shunt regulator tube offers excellent regulation over a wide range of voltages, with a design center of +185 volts. This value is set by the +185V ADJ potentiometer, R100. The voltage reference tube was selected for its extreme stability of operation.

5. MAINTENANCE (See Figures 2 and 3)

5.01 Maintenance Caution:

1.- Make all repairs with power turned OFF.

2.- When handling the cathode-ray tube, use extreme care. DO NOT hold the tube by the neck when transporting it.

3.- DO NOT leave the tube exposed on a table, bench, etc. Carefully place the tube in an empty carton with protective insulating material around it.

4.- DO NOT remove protective shield covers unless the power is turned off.

5.02 Internal Controls:

1.- LOW VOLTAGE REGULATOR ADJUST. Measure voltage at pin 3 of V13B. Rotate +185V ADJ control, located on the right center section of the chassis, for +185 volts, and set with locknut.

2.- LOW FREQUENCY ADJUST control. Apply a 60 cps square wave to the input of the scope (refer to section 3.06 for termination data) and with the BANDWIDTH switch in the WIDE position, set the INPUT switch to the signal input position. Adjust the LOW FREQ ADJ control until a minimum of tilt is observed on the screen. This control is located on the top, left rear of the verti-

cal amplifier subchassis.

3.- INPUT ATTENUATOR ADJUSTMENT

a. Adjust C7 on the 10:1 position and C5 on the 100:1 position to obtain the same input capacity of the scope as that measured from the 1:1 position of the attenuator. When a capacitance bridge is not available for this adjustment, the following procedure should be used. Connect unterminated to the IN-1-T jack, a 100-ohm resistor in series with a CAB-28 (W.E. Co.) type coil to act as a series resonant circuit, with the input capacity of the scope in the 1:1 position. Keep all leads as short as possible. Vary the frequency of a 61B or C oscillator until series resonance is obtained by a peak level display on the scope. (Series resonance should occur about 4 mc.) Switch to the 10:1 position and adjust C7 for a scope peak level display at the same resonant frequency. Switch to the 100:1 position and adjust C5 for a peak level display at the same resonant frequency.

b. Feed a 20 KC square wave to the input of the scope and adjust C4 on the 10:1 position and C2 on the 100:1 position to obtain the same square wave response as that of the 1:1 position. (See figure 10). When a square wave generator is not available for this adjustment, use the 15.75 Kc video signal of a 61B or C oscillator to adjust C4 on the 10:1 position and C2 on the 100:1 position, for the same video signal representation as was observed in the 1:1 position.

4.- PROBE ADJUSTMENT. With the INPUT switch in the 1:1 position feed a 20 Kc square wave to the probe input. Adjust C70 (see note) for the same representation on the scope as that of a square wave fed directly into the scope. The probe should be inserted into the IN-1-T or R jack with a shorting plug, applied to the IN-2-R or T jack unterminated. When a square wave generator is not available for this adjustment, use the 15.75 kc video signal of a 61B or C Signal Generator to adjust C70 for the same video signal representation displayed when fed directly to the scope. The probe should be inserted unterminated into the IN-1-T jack with a shorting plug applied to the IN-2-R jack.

NOTE: This capacitor adjustment is located behind the input connector of the probe.

5.- HIGH VOLTAGE ADJUST. With a Variac, set the A.C. line voltage for 115 volts. Adjust the HV ADJ. control, located on terminal board, under protective H.V. cover at the rear of unit, for -1400 at C46. (See Figure 3.)

6.- VIDEO AMPLIFIER COMPENSATING COIL ADJUSTMENTS.

a. Using Input condition No. 1 (see section 3.06) and the V. GAIN maximum CW, adjust the level of a 100 Kc input signal for a deflection of 2 inches on the CRT. (Replace scale with graph paper of 20 lines to the inch for these measurements).

b. Change the frequency to 5 mc at the same input level and adjust L7 (restrapping if necessary) for a 2-inch deflection.

c. Rotate the V. GAIN control so that there is a 1-inch deflection on the CRT at 100 Kc, with the signal generator producing maximum output.

d. Apply a 5 mc signal at the same input level and adjust L1 for the same deflection.

e. Using condition No. 2 of section 3.06, adjust as directed in paragraph C, above.

f. Apply a 5 mc signal at the same input level and adjust L2 for the same deflection.

g. Setting the BANDWIDTH switch to the NARROW position and the signal generator at 3.58 mc, adjust L3 and L4 for a null on the CRT.

5.03. Voltage and Waveform Measurements:

Figure 6 indicates the proper control settings for waveform and voltage measurements. Voltage measurements were made with the KS-14510-L1 volt-ohm milliammeter plus a KS-14709-L1 High Voltage Probe, using a 60 megohm internal resistor, for high voltage measurements. AC peak-to-peak voltages were determined with a calibrated oscilloscope having a bandwidth of better than 2 MC.

5.04 Horizontal Tracking Adjust:

a. With SWEEP FREQ in the LO position, lock the signal in to display two vertical intervals on the scope.

b. Rotate SWEEP FREQ control to the HI position.

c. Adjust the HOR. TRACK ADJ. capacitor, C57, for a locked in display of two horizontal sync pulses on the scope.

KS-15512, LIST 5A OSCILLOSCOPE

TUBE			PLATE				GRID				CATHODE				SCREEN	
REF SYM	TYPE	FUNC	PIN NO	VOLTAGE D.C.	VOLTAGE A.C.	WAVEFORM	PIN NO.	VOLTAGE D.C.	VOLTAGE A.C.	WAVEFORM	PIN NO.	VOLTAGE D.C.	VOLTAGE A.C.	WAVEFORM	PIN NO.	VOLT D.C.
V1	404A	VERT AMP	6	220	88		1	45	1		4	48	8		8	220
V2	404A	VERT AMP	6	215	84		1	45			4	48	14		8	225
V3	404A	VERT AMP	6	330	1.3		1	205	.88		4	220	78		8	340
V4	404A	VERT AMP	6	330	1.3		1	205	.84		4	220	72		8	340
V5	418A	VERT AMP	2	150	43		8	6.5	1.3		4	9			5	170
V6	418A	VERT AMP	2	160	43		8	6.5	1.3		4	9			5	165
V7A	1/2 6AL5	D.C. SETTER	2	55							5	85	43			
V7B	1/2-6AL5	D.C. SETTER	7	65	43						1	110				
V8A	1/2-396A	CATH FOLL	6	180			7	2	0		8	8	8			
V8B	1/2-396A	CATH FOLL	4	180			3	2	1		2	7	8			
V9A	1/2-6SN7	SWEEP GEN	2	100	65		1	0	1.8		3	3	9			
V9B	1/2-6SN7	SWEEP GEN	5	40	10		4	-10	45		6	3	9			
V10B	1/2-6SL7	H.V. REG	5	500			4	-6			6	0				
V10A	1/2-6SL7	BLANK AMP	2	110	41		1	3.5	5		3	7				
V11A	1/2-6AW8-A	HOR AMP	3	105	4		2	15	.7		1	17	5			
V11B	1/2-6AW8-A	HOR AMP	9	250	120		7	105	.7		6	115	1.6		8	280
V12A	1/2-6AW8-A	HOR AMP	3	105	1.7		2	15			1	17	06			
V12B	1/2-6AW8-A	HOR AMP	9	250	120		7	105	1.7		6	115	6		8	280
V13A	1/2-6BL7	D.C. Series Rect	2	340			1	175			3	185				
V13B	1/2-6BL7	Sweep Bootstrap	5	185			4	39	10		6	50	9			
V14	5R4GY	L.V. RECT									2	360				
V15	2X2A	H.V. RECT	CAP	-1700												
V16	5UP1	DISP	8	115			2	-1350			3	-1000			8	115
V17A	1/2-6AW8-A	L.V. SHUNT REG	3	175			2	80			1	6 8				
V17B	1/2-6AW8-A	SYNC SEP AMP	9	100	28		7	0	7		6	2.7			8	110
V18	OG 3/85A2	VOLT REG	5	82												
V19A	1/2-6SL7	SYNC SEP	2	90	15		1	-3	7.5		3	0	0			
V19B	1/2-6SL7	CATH FOLL	5	185			4	2	16		6	6	12			

TEST CONDITIONS FOR VOLTAGE AND WAVEFORM MEASUREMENTS

Controls	Test Conditions
Line Voltage	115V., 60 cps
Video Signal Input	61C Video Signal (100% All White)
Sweep Frequency	Hi-Position (7875 cps)
Sync	Negative
Intensity	Normal
Focus	Normal
Bandwidth	Wide
Input	1:1 (Unbalanced Input Used)
H. Gain	5 inch Deflection
V. Gain	2 inch Deflection
Normal - Special Switch	Normal - OR

NOTES

AC voltage measurements are made peak to peak on an oscilloscope with a wide band amplifier such as Tektronix Model 524D.

DC voltage measurements are made with a 20,000 ohms-per-volt meter.

Figure 6. Voltage and Waveform Chart.

6. TECHNICAL SPECIFICATIONS

Power Input	105-125 volt, 1.9 amps, 50/60 cps
Fuse Protection	3 Amp., SLO-BLOW
Cathode Ray Tube	5UP1
Vertical Amplifier	
Deflection Sensitivity	NARROW: 0.020 volts/inch 1958A IRE: 0.200 volts/inch WIDE: 0.200 volts/inch
Signal Level Range	0.015 to 300 volt p-p
Input Impedance (with Probe)	130,000 ohms, 50 MMF 1 Megohm, 114 MMF
Response (3 db Down)	NARROW: 300 KC 1958A IRE: 2 MC WIDE: 10 MC
(Square Wave)	No tilt at 60 cps
Horizontal Amplifier (EXT SWEEP)	
Input Impedance	100,000, 200 MMF
Response (3 db down)	35 Kc
Deflection Sensitivity (Max)	0.1 volt p-p/inch
Horizontal Expansion	LO: 20 Tube Diameters HI: 12 Tube Diameters
Sweep Frequency	LO: 18 to 80 cps HI: 4 to 16 KC
Blanking	Continuous Return Trace Blanking

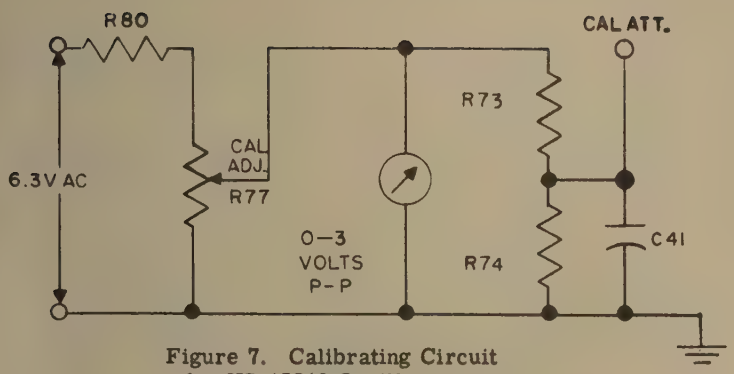


Figure 7. Calibrating Circuit for KS-15512 Oscilloscope

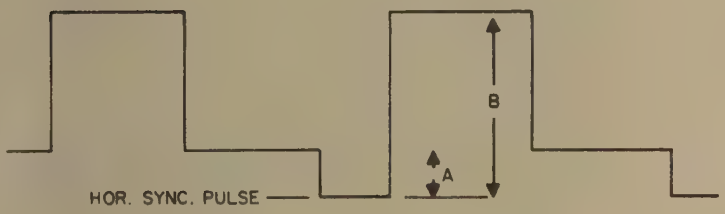
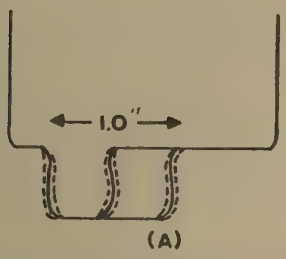
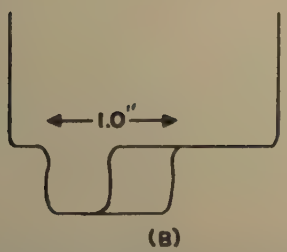


Figure 8. Picture Signal

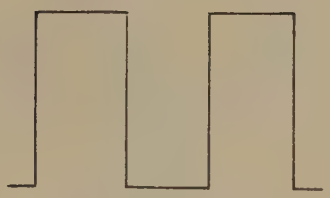


Incorrect Synchronization Adjustment or Jitter in T. V. Synchronizing Signal

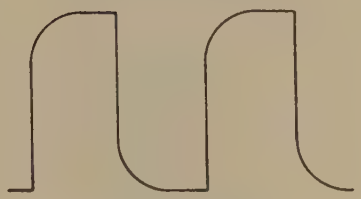


Correct Synchronization Adjustment and no Jitter in T. V. Signal

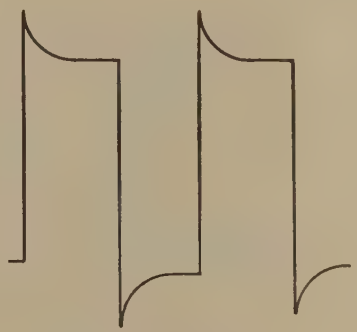
Figure 9. Horizontal Sync. Pulse Interval



(A) Correct Shape



(B) Underpeaked



(C) Overpeaked

Figure 10. Square Wave Response

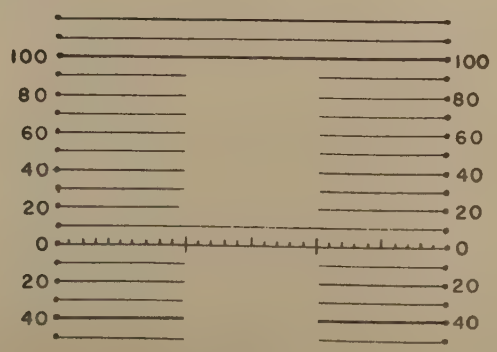


Figure 11. Scale Signal Measuring Level

TABLE III - MAINTENANCE PARTS LIST - SUPPLEMENT NO. 1C

The following parts have been authorized for use as alternates for the parts listed:

Schematic Ref. No.	Mfr.	Mfr. Designation
C1, C9, C10	17	WMF4W1
C40, C52	38	1MP2-P1
C41	38	1MP2-S1
C43, C44, C48	38	1MP4-P1
C56	38	1MP4-P15
C63	38	1MP2-P25
C65, C67	38	1MP6-S1
C66	38	1MP2-S5
L6	35	F-632
T2	31	22161-A
T3	39	5223
V18	40	OG3
C54, C74, C25, C26	38	107C105K
C31, C33	38	107F254K
C34, C35, C37, C39	38	107E104K
L5, L8	41	I-10877
R98	7	8000-0750-50K

Mfr. Code No.	Manufacturer
38	General Instrument Corporation
39	Berkshire Transformer Company
40	Tung-Sol Electric, Inc.
41	Stanwyck Winding Co., Inc.

TABLE III - MAINTENANCE PARTS LIST

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
C1	Cap., Fixed, 1.0 uf 400Vdcw paper tubular	264-139	8	620M or 621M
C2	Cap., Var., 1.5-7 uuf ceramic	264-113	9	TS2A-1.5
C3	Cap., Fixed, 750 uuf ±5% Mica, 500V	264-131	10	CM20E751J
C4	Cap., var. 5-20 uuf, ceramic	264-114	9	TS2A-5
C5	Cap., var. 7-45 uuf, ceramic	264-115	9	TS2A-7
C6	Cap., fixed 1.0uf, Tantalum, tub. 150V dcw	264-103	4	102D44
C7	Cap., var., 5-20 uuf, ceramic	264-114	9	TS2A-5
C8	Cap., fixed, 51uuf ± 5% mica, 500V	264-129	10	CM15E510J
C9	Cap., fixed, 1.0uf 400V dcw paper tubular	264-139	8	620M or 621M
C10	Cap., fixed, 1.0uf 400Vdcw paper tubular	264-139	8	620M or 621M
C11	Cap., fixed, 4x20uf, 450Vdcw Elect.	264-99	4 16	TVL 4763 or PLQ 4520
C12	Not used			
C13	Cap., fixed 40-40-40uf 450Vdcw Electrolytic	264-402	4	TVL-3787
C14	Cap., fixed, 0.01uf Disc cap., 600V	264-133	12	DD-6103
C15	Cap., fixed, 40-40-40 uf 450V dcw Electrolytic	264-402	4	TVL-3787
C16	Cap., fixed, 51 uuf ± 5% mica	264-122	10	DM15-510J
C17	Cap., fixed, 51 uuf ± 5% mica	264-122	10	DM15-510J
C18	Cap., fixed, 0.01uf Disc cap, 600V	264-133	12	DD-6103
C19	Cap., fixed, 0.01uf Disc cap, 600V	264-133	12	DD-6103
C20	Cap., fixed, 22uuf ± 5%, mica	264-121	10	CM15C220J
C22	Cap., fixed, 22uuf ± 5%, mica	264-121	10	CM15C220J
C24	Not Used			
C25	Cap., fixed, 1.0 uf 200Vdcw paper tubular	264-120	8	620M
C26	Cap., fixed, 1.0 uf 200V dcw paper tubular	264-120	8	620M
C27	Cap., 1.0 uf, 600V, Channel Type, Case CP65	264-105	4 17	PN86 or YAB6100
C28	Cap., 0.01uf, 600V, Disc cap.	264-133	12	DD-6103
C29	Cap., 0.01uf, 600V, Disc Cap.	264-133	12	DD-6103
C30	Not Used			
C31	Cap., 0.25uf, 400V, ± 10%	264-119	8	620M or 621M

TABLE III - MAINTENANCE PARTS LIST (cont'd.)

Schem. Ref. No.	Description	ITI Part No.		Mfr. Designation
C32	Cap. 4 x 20 uf, 450V	264-402	4 16	TVL 4763 or PLQ 4520
C33	Cap. 0.25uf, 400V ± 10%	264-119	8	620M or 621M
C34	Cap. 0.1 uf, 400V ± 10%	264-118	8	620M or 621M
C35	Cap. 0.1 uf, 400V ± 10%	264-118	8	620M or 621M
C36	Not Used			
C37	Cap. 0.1 uf, 400V ± 10%	264-118	8	620M or 621M
C38	Cap. 4 uf, 600V	264-104	4 17	OGP3 or TNAD 6040
C39	Cap. 0.1 uf, 400V ± 10%	264-118	8	620M or 621M
C40	Cap. 0.1 uf, 200V	264-109	16	330201
C41	Cap. 0.01 uf, 200V	264-106	16	330211
C42	Cap. 2 uf, 450V	264-134	17	BR-245
C43	Cap. 0.1 uf, 400V	264-110	16	330401
C44	Cap. 0.1 uf, 400V	264-110	16	330401
C45	Cap. 0.5 uf, 2KV	264-136	17 16	TJU 20005 or 7120- .5P
C46	Cap. 0.5 uf, 2KV	264-136	17 16	TJU 20005 or 7120- .5P
C47	Cap. 4 x 20 uf, 450V	264-99	4 16	TVL4763 or PLQ 4520
C48	Cap. 0.1 uf, 400V	264-110	16	330401
C49	Cap. 220 uuf, 500V ± 5%	264-125	10	CM15E221J
C50	Cap. 620 uuf, 500V ± 5%	264-130	10	CM20A621J
C51	Cap. 1000 uf, 6V Electrolytic	264-100	4	BFP
C52	Cap. 0.1 uf, 200V	264-109	16	330201
C53	Cap. 68uuf, 500V, ± 10%, Mica	264-128	10	CM20A680K
C54	Cap. 1 uf, 200V ± 10%	264-118	8	620M
C55	Cap. 12 uf, 450V	264-135	17	BR 1245
C56	Cap. 0.15 uf, 400V	264-111	16	3304015
C57	Cap. 190-760 uuf	264-117	18	305
C58	Cap. 6800 uuf, 500V, ± 10%, Mica	264-132	10	CM35A682K
C59	Not Used			
C60	Cap. 0.01 uf, 1000V	264-102	4	10TM-S1
C61	Not Used			
C62	Not Used			
C63	Cap. 0.25 uf, 200V	264-112	16 17	3302025 or PJ2P25
C64	Cap. 0.05 uf, 2000V	264-137	20 19	OT 467 or 2089 MX

TABLE III - MAINTENANCE PARTS LIST (cont'd)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
C65	Cap. 0.01 uf, 600V	264-107	16	330611
C66	Cap. 0.05 uf, 200V	264-108	16	330215
C67	Cap. 0.01 uf, 600V	264-107	16	330611
C68	Cap. 0.1 uf, 1000V	264-101	16	331001
C69	Cap. 12 uuf ± 5%, 300V	264-98	21	N-450
C70	Cap. 1-8 uuf, Tub. Trimmer	264-116	9	#532-10
C71	Not Used			
C72	Cap. 0.01 uf, 600V	264-133	12	MD-103
C73	Not Used			
C74	Cap. 1 uf, 200V ± 10%	264-120	8	620M
C75	Cap. 1 uf Nominal, Match with T3			
C76	Cap. 47 uuf, 500V ± 5%	264-126	10	CM15E470J
C77	Cap. 12 uf, 450V	264-135	17	BR 1245
C78	Cap. 150 uuf, 500V ± 5%	264-124	10	CM15E151J
C79	Cap. 68 uuf, 500V ± 5%	264-123	10	DM15-680
C80	Cap. 450 uuf, 500V, ± 5%	264-127	10	DM15-511
C81	Cap. 68 uuf, 500V, ± 5%	264-123	10	DM15-680
C82	Cap. 450 uuf, 500V ± 5%	264-127	10	DM15-511
CR1	Crystal	264-279	29	1N34A
CR2	Crystal	264-280	26	1N482
CR3	Not Used			
CR4	Crystal) Matched Pair	264-281	26	SV3005
CR5	Crystal)	264-281	26	SV3005
CR6	Crystal	264-280	26	1N482
F1	Fuse, 3 amperes	264-191	23	AGC-3
J1	Jack	264-174	24	470C
J2	Jack	264-174	24	470C
J3	Jack	264-174	24	470C
J4	Jack	264-174	24	470C
J5	Jack	264-177	24	477B

TABLE III - MAINTENANCE PARTS LIST (cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
J6	Jack	264-177	24	477B
J7	Jack	264-177	24	477B
J8	Jack	264-177	24	477B
P5	Plug	264-176	24	358A
J10	Receptacle	264-175	25	7486
J11	Jack	264-174	24	470C
L1	Inductor 60 uh	264-212	34	934014
L2	Inductor 60 uh	264-212	34	934014
L3	Inductor 51 uh	264-211	34	934120-1
L4	Inductor 51 uh	264-211	34	934120-1
L5	Inductor 7.5 uh ± 5%	264-213	7	CLA
L6	Inductor 5h @ 250 MA	264-207	35	ST1912
L7	Inductor 0.9 uh	264-210	34	934015
L8	Inductor 7.5 ± 5% uh	264-213	7	CLA
L9	Inductor 6.7 uh	264-208	34	934014
L10	Inductor 1 uh	264-209	34	934929
L13	Inductor 41 uh	264-214	15	43-27
L14	Inductor 41 uh	264-214	15	43-27
M1	Meter	264-282	34	#476 w/ 153330 scale
N1	Network	264-138	12	PC101
R1	Res. 129K, 1/2W ± 1%	*	1	C173A
R2	Res. 1.31K, 1/2W ± 1%	*	1	C173A
R3	Res. 117K, 1/2W ± 1%	*	1	C173A
R4	Res. 14.4K, 1/2W ± 1%	*	1	C173A
R5	Res. 15, 4W Pot with STDP switch attached 3/8" Bushing Shaft extended 3/8" beyond Bushing	*	11	CM19541
R6	Res. 130K, 1/2W ± 5%	*	2	
R7	Res. 33K, 1/2W ± 1%	*	1	C173A
R8	Res. 101.8K, 1/2W ± 1%	*	1	C173A
R9	Res. 240, 1/2W ± 5%	*	2	
R10	Res. 130K, 1/2W ± 5%	*	2	
R11	Res. 240, 1/2W ± 5%	*	2	
R12	Res. 10, 1W, 10%	*	2	
R13	Res. 47, 1/2W ± 10%	*	2	
R14	Res. 2500, 2W Pot "B" Taper 3/8" Bush 2" Overall Shaft	*	2	JB2521 w/P3200 Shaft

Note: All resistance values are in ohms.

*Order by complete description, referencing KS-15512, L5A

TABLE III - MAINTENANCE PARTS LIST (cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
R15	Res. 2610, 2W ± 1% w/insulated caps	*	3	S25
R16	Res. 2610, 2W ± 1% w/insulated caps	*	3	S25
R17	Res. 470, 1/2W ± 10%	*	2	
R18	Res. 470, 1/2W ± 10%	*	2	
R19	Res. 47, 1/2W ± 10%	*	2	
R20	Res. 27K, 1W ± 10%	*	2	
R21	Res. 27K, 1W ± 10%	*	2	
R22	Res. 1 Meg. 1/2W ± 10%	*	2	
R23	Res. 1000, 1/2W ± 10%	*	2	
R24	Res. 1000, 1/2W ± 10%	*	2	
R25	Res. 330, 1/2W ± 5%	*	2	
R26	Res. 5100, 1W ± 5%	*	2	
R27	Res. 2000, 5W ± 5%	*	4	27E
R28	Res. 4590, 2W ± 1% w/insulated end caps	*	3	S25
R29	Res. 430, 1/2W ± 1%	*	1	C173A
R30	Res. 4590, 2W ± 1% w/ insulated end caps	*	3	S25
R31	Res. 330, 1/2W ± 5%	*	2	
R32	Res. 1 Meg. 1/2W ± 10%	*	2	
R33	Res. 430, 1/2W ± 1%	*	1	C173A
R34	Res. 200K, 1/2W ± 1%	*	1	C173A
R35	Res. 43K, 1/2W ± 5%	*	2	
R36	Res. 10, 1W ± 10%	*	2	
R37	Res. 43K, 1/2W ± 5%	*	2	
R38	Res. 2200, 1/2W ± 1%	*	1	C173A
R39	Res. 130, 1/2W ± 5%	*	2	
R40	Res. 130, 1/2W ± 5%	*	2	
R41	Res. 27, 1/2W ± 1%	*	1	C173A
R42	Not Used			
R43	Res. 27, 1/2W ± 1%	*	1	C173A
R44	Res. 47, 1/2W ± 10%	*	2	
R45	Res. 2500, 10W NON-IND	*	5	10XMOD. NON-IND
R46	Res. 47, 1/2W ± 10%	*	2	
R47	Res. 1000, 1/2W ± 1%	*	1	C173A
R48	Not Used			
R49	Res. 1000, 1/2W ± 1%	*	1	C173A
R50	Res. 1500, 4W ± 1% w/insulating end caps	*	3	S30

Note: All resistance values are in ohms.

*Order by complete description, referencing KS-15512, L5A

TABLE III - MAINTENANCE PARTS LIST (cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
R51	Res. 1500, 4W ± 1% w/insulating end caps	*	3	S30
R52	Res. 22K, 1/2W ± 5%	*	2	
R53	Res. 22K, 1/2W ± 5%	*	2	
R54	Not Used			
R55	Not Used			
R56	Res. 30K, 1/2W ± 5%	*	2	
R57	Res. 30K, 1/2W ± 5%	*	2	
R58	Res. 100K, 2W Dual Pot Lin Taper 1/4" Bush 5/8" slot shaft	*	2	JJU1041 w/SD2040 shaft
R59	Res. 9770, 1/2W ± 1%	*	1	C173A
R60	Res. 100, 1/2W ± 10%	*	2	
R61	Res. 240 5K, 1/2W ± 1%	*	1	C173A
R62	Res. 100, 1/2W ± 10%	*	2	
R63	Res. 47, 1/2W ± 10%	*	2	
R64	Res. 80, 2W ± 1% w/insulated end cap	*	3	S25
R65	Res. 47, 1/2W ± 10%	*	2	
R66	Not Used			
R67	Res. 10K, 5W	*	4	27E
R68	Res. 10K, 5W	*	4	27E
R69	Res. 4.7 Meg. 1/2W ± 10%	*	2	
R70	Res. 4.7 Meg. 1/2W ± 10%	*	2	
R71	Res. 0.5 Meg. 2W Dual Pot Lin Taper 3/8" Bush 3/4" Shaft	*	2	JJU5041 w/ P3048 shaft
R72	Not Used			
R73	Res. 5500, 1/2W ± 1%	*	1	C173A
R74	Res. 10K. 1/2W ± 1%	*	1	C173A
R75	Res. 10K, 1/2W ± 5%	*	2	
R76	Res. 100K, 1/2W ± 5%	*	2	
R77	Res. 50, WW Pot Lin Taper Shaft extending 3/8" beyond 3/8" Bush	*		SS-393-2-25
R78	Res. 4700, 1W ± 10%	*	2	
R79	Res. 10K, 2W ± 5%	*	2	
R80	Res. 12, 1W ± 5%	*	2	
R81	Res. 1000, 1/2W ± 10%	*	2	
R82	Res. 100, 1/2W ± 5%	*	2	
R83	Res. 1 Meg. 1/2W ± 10%	*	2	

Note: All resistance values are in ohms.

*Order by complete description, referencing KS-15512, L5A

TABLE III - MAINTENANCE PARTS LIST (cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
R84	Res. 33K, 1/2W ± 10%	*	2	
R85	Res. 180, 1/2W ± 10%	*	2	
R86	Res. 5600, 1W ± 5%	*	2	
R87	Res. 10K, 2W ± 5%	*	2	
R88	Res. 22K, 2W ± 5%	*	2	
R89	Res. 4.7 Meg. 1/2W ± 10%	*	2	
R90	Res. 1000, 1/2W ± 10%	*	2	
R91	Res. 33K, 2W ± 10%	*	2	
R92	Res. 33K, 2W ± 10%	*	2	
R93	Res. 5K, 2W Pot 3/8" Bush 3/4" Shaft Lin Taper	*	2	JU5021 w/ P3048 shaft
R94	Res. 3.3K, 1/2W ± 5%	*	2	
R95	Res. 8200, 1/2W ± 10%	*	2	
R96	Res. 10K, 1/2W ± 10%	*	2	
R97	Res. 470K, 1/2W ± 10%	*	2	
R98	Res. Pot 50K, 2W ± 5%, 3600° Rot 1/2"Split Bushing w/knurled Nut, Shaft Extended 1/2"beyond Bushing. HA-100F	*	13	C5663-1
R99	Res. 4.7 Meg. 1/2W ± 10%	*	2	
R100	Res. Pot, 100K, 2W 3/8" Bush, 5/8" Slotted shaft, Lin Taper	*	2	JU1041 w/ SD3040 shaft
R101	Res. Pot, 100K, 2W 3/8"Bush, 3/4" Shaft Lin Taper	*	2	JU1041 w/ P3048 shaft
R102	Res. 270K, 1/2W ± 10%	*	2	
R103	Res. 4.7K, 1/2W ± 5%	*	2	
R104	Res. 1200, 1/2W ± 10%	*	2	
R105	Res. 39K, 1/2W ± 10%	*	2	
R106	Res. 100K, 1/2W ± 10%	*	2	
R107	Res. 100K, 1/2W ± 10%	*	2	
R108	Res. Pot, 1Meg. 2W, 3/8"Bush, 3/4" Shaft, Lin Taper	*	2	JU1051 w/ P3048 shaft
R109	Res. 100K, 1/2W ± 10%	*	2	
R110	Res. 30K, 10W	*	5	10F
R111	Res. 100K, 1/2W ± 10%	*	2	
R112	Res. 130K, 1/2W ± 5%	*	2	
R113	Res. 470, 1/2W ± 10%	*	2	
R114	Res. 470, 1/2W ± 10%	*	2	

Note: All resistance values are in ohms.

*Order by complete description, referencing KS-15512, L5A

TABLE III - MAINTENANCE PARTS LIST (Cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
R115	Res. 1 Meg. 1/2W ± 10%	*	2	
R116	Res. 150K, 1/2W ± 10%	*	2	
R117	Res. 22K, 2W ± 10%	*	2	
R118	Res. 100K, 1/2W ± 10%	*	2	
R119	Res. 56K, 1/2W ± 5%	*	2	
R120	Res. 150, 1/2W ± 5%	*	2	
R121	Res. 6800, 1/2W ± 5%	*	2	
R122	Res. 16K, 1/2W ± 5%	*	2	
R123	Res. 240K, 1/2W ± 5%	*	2	
R124	Res. 330, 1/2W ± 5%	*	2	
R125	Res. 330, 1/2W ± 5%	*	2	
R126	Res. 150, 1/2W ± 5%	*	2	
R127	Res. 16K, 2W ± 5%	*	2	
R128	Res. 47K, 2W ± 10%	*	2	
R129	Res. 68K, 2W ± 10%	*	2	
R130	Res. 68K, 2W ± 10%	*	2	
R131	Res. 68K, 2W ± 10%	*	2	
R132	Res. 68K, 2W ± 10%	*	2	
R133	Res. 16K, 1/2W ± 5%	*	2	
R134	Res. 4.7 Meg. 1/2W ± 10%	*	2	
R135	Res. 100K, 2W Pot Lin Taper, 3/8" Bush, 5/8" Slotted Shaft	*	2	JU1041 w/ SD3040 Shaft
R136	Res. 33K, 1/2W ± 10%	*	2	
R137	Res. 330K, 1W ± 10%	*	2	
R138	Res. 500K, 2W Pot Lin Taper, 3/8" Bush 5/8" Slotted Shaft	*	2	JU5041 w/ SD3040 Shaft
R139	Res. 330K, 1W ± 10%	*	2	
R140	Res. 330K, 1W ± 10%	*	2	
R141	Res. 250K, 2W Pot Lin Taper, 3/8" Bush 5/8" Slotted Shaft	*	2	JU2541 w/ SD3040 Shaft
R142	Res. 22K, 1/2W ± 5%	*	2	
R143	Res. 68K, 1/2W ± 5%	*	2	
R144	Res. 1 Meg. 1/2W ± 10%	*	2	
R145	Res. 330K, 1W ± 10%	*	2	
R146	Res. 100K, 1/2W ± 10%	*	2	
R147	Res. 270K, 1W ± 10%	*	2	
R148	Res. 2200, 1/2W ± 5%	*	2	

Note: All resistance values are in ohms.

*Order by complete description, referencing KS-15512-L5A

TABLE III - MAINTENANCE PARTS LIST (Cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
R149	Res. 47K, 1/2W ± 10%	*	2	
R150	Res. 51K, 1/2W ± 5%	*	2	
R151	Res. 0.5 Meg. 2W Pot, 3/8" Bush 3/4" Slotted Shaft, Lin Taper	*	2	JU5041 w/ SD3048 Shaft
R152	Res. 910K, 1/2W ± 1% Deposited Carbon	*	7	DCC
R153	Res. 470K, 1/2W ± 1% Deposited Carbon	*	7	DCC
R154	Res. 2200, 1/2W ± 5%	*	2	
R155	Res. 2.2 Meg. 1/2W ± 5%	*	2	
R156	Res. 2.2 Meg. 1/2W ± 5%	*	2	
R157	Res. 68K, 1/2W ± 5%	*	2	
R158	Res. 100, 1/2W ± 10%	*	2	
R159	Res. 100, 1/2W ± 10%	*	2	
R160	Res. 100K, 1/2W ± 10%	*	2	
R161	Res. 33K, 1/2W ± 10%	*	2	
R162	Not Used			
R163	Res. 82K, 1/2W ± 5%	*	2	
R164	Res. 150K, 1W ± 10%	*	2	
R165	Res. 30K, 5W ± 5%	*	4	KT
R166	Res. 5100, 1/2W ± 5%	*	2	
R167	Res. 2700, 1/2W ± 5%	*	2	
R168	Res. 12K, 1/2W ± 5%	*	2	
S1	Switch, Rotary, Steatite, miniature, non-shorting 2 section, 2 poles per section, 6 positions	264-155	12	PAO24-1223
S2	Switch, Rotary, Phenolic non-shorting, Single Section, single pole, 3 position	264-156	12	PA201-067
S3	Switch, Single Section, 6 pole, 3 positions	264-157	20	3263J
S4	Switch, Rotary, Steatite, miniature, non-shorting 3 section, 3 poles per section, 5 positions	264-159	12	PAO24-1181
S5	Switch, Part of R5			
S6	Switch, slide phenolic, non-shorting 2 section, 2 poles per section, 2 position	264-158	27	170
T1	Transformer, Power	264-204	31	#24606
T2	Transformer, H.V.	264-206	14	ST2611
T3	Transformer, Fil.matched with Cap. C75	264-205	32	W6916

Note: All resistance values are in ohms

*Order by complete deecription, referencing KS-15512-L5A

TABLE III - MAINTENANCE PARTS LIST (Cont'd.)

Schem. Ref. No.	Description	ITI Part No.	Mfr.	Mfr. Designation
V1	Tube, electron, 404A	* *	24	
V2	Tube, electron, 404A	* *	24	
V3	Tube, electron, 404A	* *	24	
V4	Tube, electron, 404A	* *	24	
V5	Tube, electron, 418A	* *	24	
V6	Tube, electron, 418A	* *	24	
V7	Tube, electron, 6AL5	* *	28, 29, 33	
V8	Tube, electron, 396A	* *	24	
V9	Tube, electron, 6SN7GT	* *	28,29,33	
V10	Tube, electron, 6SL7GT	* *	28,29,33	
V11	Tube, electron, 6AW8A	* *	28,29	
V12	Tube, electron, 6AW8A	* *	28,29	
V13	Tube, electron, 6BL7GT	* *	28,29,33	
V14	Tube, electron, 5R4WGY or 5R4GY	* *	28,29,33	
V15	Tube, electron, 2X2A	* *	28,29,33	
V16	Tube, electron, 5UP1, CRT	* *	28,33	
V17	Tube, electron, 6AW8A	* *	28,29	
V18	Tube, electron, 85A2/OG3 Amperex*	* *	30	
V19	Tube, electron, 6SL7-GT	* *	28,29,33	
XF1	Holder, Fuse, Panel MT. 3AG	264-190	23	HKP

*As temporary replacement ONLY, R.C.A. 5651 may be used.

**Order by complete description, referencing KS-15512-L5A

TABLE IV LIST OF MANUFACTURERS

MFR. CODE NO.	MANUFACTURER
1	Mepco, Inc.
2	Allen-Bradley Co.
3	Corning Glass Works
4	Sprague Electric Co.
5	Ward-Leonard Electric Co.
6	Ohmite Mfg. Co.
7	International Resistance Co.
8	Good-All
9	Erie Resistor Corp.
10	Arco Electronics
11	Clarostat Mfg. Co.
12	Centralab Div. Globe-Union, Inc.
13	Circuit Instruments, Inc.
14	Sterling Transformer Corp.
15	Jeffers Electronics, Inc.
16	Sangamo Electric Co.
17	Cornell-Dubilier Elec. Corp.
18	El Menco
19	Aerovox Corp.
20	P.R. Mallory & Co.
21	Mucon Corp.
22	Cutler-Hammer, Inc.
23	Bussmann Mfg. Co.
24	Western Electric Co., Inc.
25	Harvey Hubbell
26	Transitron
27	Oak Mfg. Co.
28	Radio Corp. of America
29	Sylvania
30	Mullard, England (U.S. Distrib. Amperex Elec. Corp., Hicksville, N.Y.)

TABLE IV LIST OF MANUFACTURERS

MFR. CODE NO.	MANUFACTURER
31	Chicago Std. Transf. Co.
32	Raytheon Mfg. Co.
33	General Electric Co., Inc.
34	Manufacturer of Oscilloscope
35	Freed
36	Weston Instrument
37	Micamold Electronic Sales

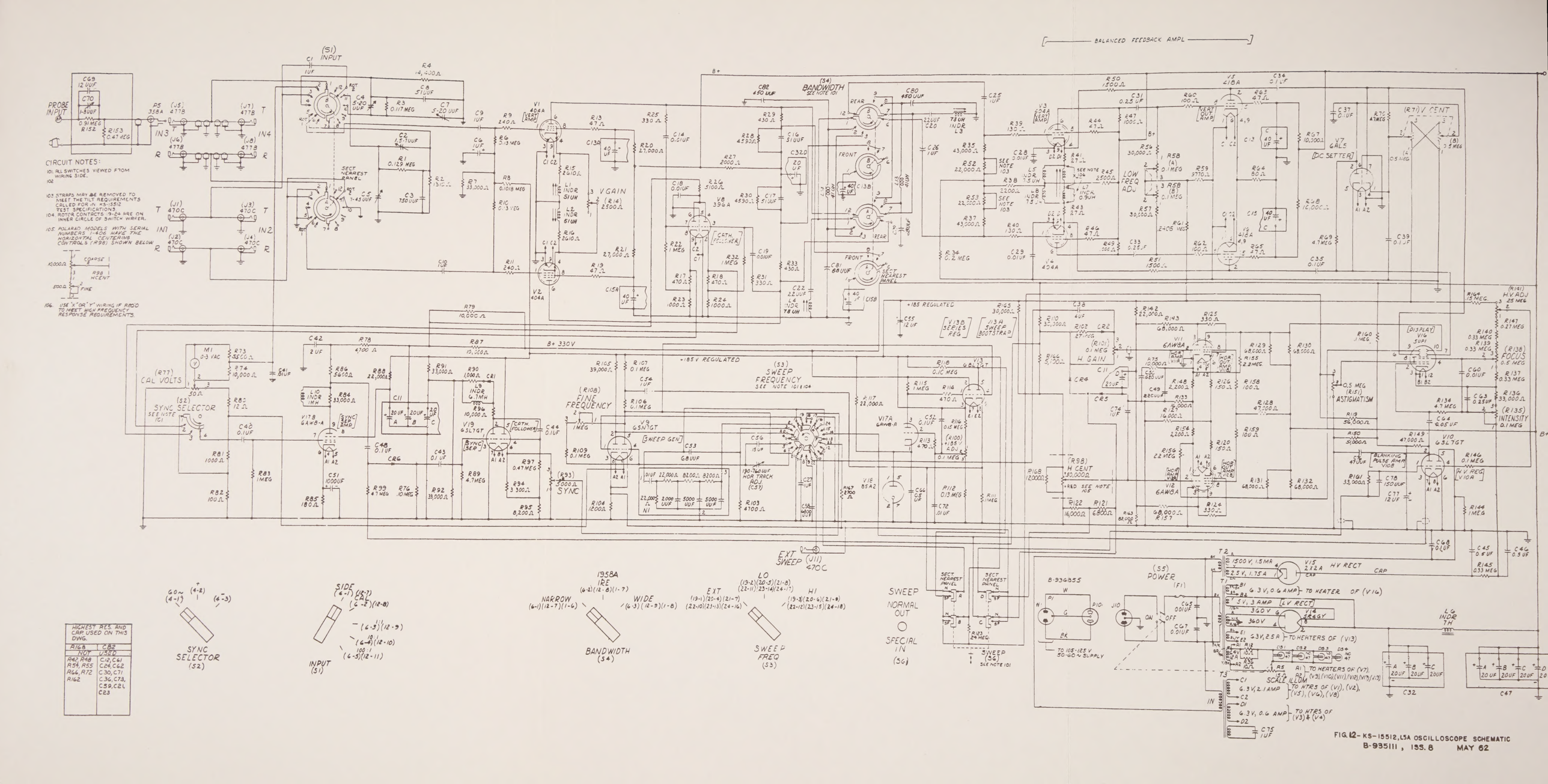
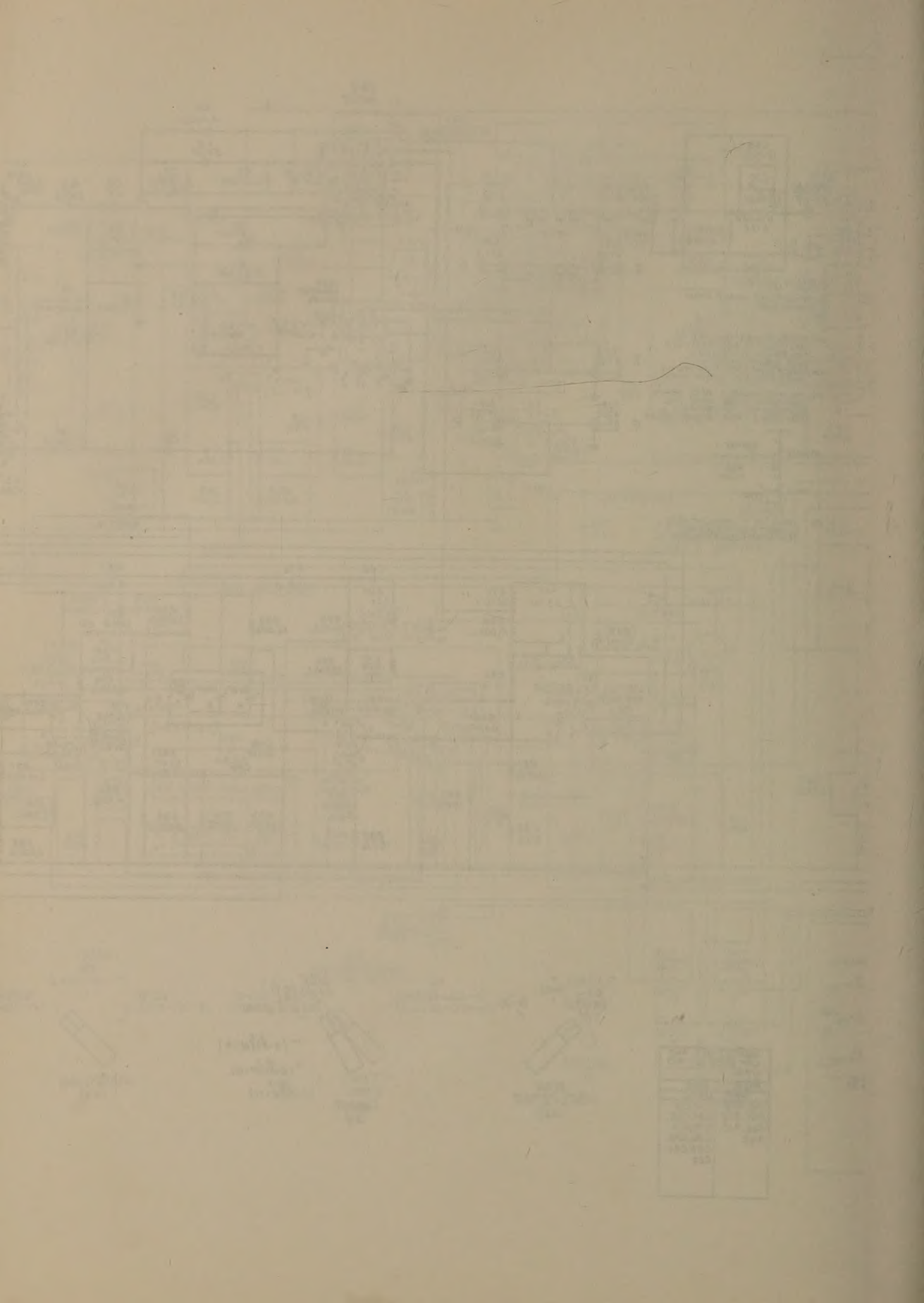

BALANCED FEEDBACK AMPL
(S1) INPUT
PROBE INPUT
CIRCUIT NOTES:
101. ALL SWITCHES VIEWED FROM WIRING SIDE.
102.
103. STRAPS MAY BE REMOVED TO MEET THE TILT REQUIREMENTS CALLED FOR IN KS-15512 TEST SPECIFICATIONS.
104. ROTOR CONTACTS 1-9-24 ARE ON INNER CIRCLE OF SWITCH WAFER.
105. POLARAD MODELS WITH SERIAL NUMBERS 1-605 MAKE THE HORIZONTAL CENTERING CONTROL'S (R98) SHOWN BELOW.
106. USE "X" OR "Y" WIRING IF ROD TO MEET HIGH FREQUENCY RESPONSE REQUIREMENTS.
(S4) BANDWIDTH SEE NOTE 101
(S3) SWEEP FREQUENCY SEE NOTE 101 & 104
(S5) POWER
(S2) SYNC SELECTOR SEE NOTE 101
(R77) CAL VOLTS
(R108) FINE FREQUENCY
(R93) SYNC
(R98) H CENT
(R121) H GAIN
(R138) FOCUS
(R135) INTENSITY
(R151) ASTIGMATISM
(R141) HV ADJ
(R137) V CENT
V GAIN
LOW FREQ ADJ
V7 6AL5 (DC SETTER)
SWEEP FREQUENCY SEE NOTE 101 & 104
+185 REGULATED
B+ 330V
SYNC SELECTOR (S2)
INPUT (S1)
BANDWIDTH (S4)
SWEEP FREQ (S3)
SWEEP NORMAL OUT SPECIAL IN (S6)
EXT SWEEP (J11) 470C
SWEEP (S6) SEE NOTE 101
B-935B55
TO 105-125 V, 50-60 ~ SUPPLY
1500 V, 1.5 MA
2.5 V, 1.75 A
6.3 V, 0.6 AMP
5 V, 3 AMP
360 V
6.3 V, 2.5 A
6.3 V, 2.1 AMP
6.3 V, 0.6 AMP
TO HEATER OF (V16)
TO HEATERS OF (V13)
TO HEATERS OF (V7), (V9), (V10), (V11), (V12), (V7), (V13)
TO HTRS OF (V1), (V2), (V5), (V6), (V8)
TO HTRS OF (V3) & (V4)
SCALE ILLUM
HIGHEST RES. AND CAP USED ON THIS DWG.
R168 NOT USED
C82 USED
R42, R48, R54, R55, R46, R72, R162
C12, C41, C24, C62, C30, C71, C36, C73, C59, C21, C23

FIG. 12- KS-15512, L3A OSCILLOSCOPE SCHEMATIC
B-935111, 133.8 MAY 62



82059